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Comparison of Dynamic and Isometric Resistance Training in Knee Osteoarthritis

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ABSTRACT:
As strength training affects the outcome of OA knee, the present study aims to compare the effect of multiple angle isometric resistance training and dynamic resistance training on pain and function among adults with OA knee. Using a pre-post experimental design, a total of sixty subjects were selected on the basis of inclusion and exclusion criteria; Group 1 (n=30) was administered with multiple angle isometric resistance training and Group 2 (n=30) was administered with dynamic resistance training for six weeks. The muscle strength was measured using strain gauge, pain of the subjects was evaluated on Visual analog Scale, and function of knee was measured on reduced WOMAC scale. The result indicates that both the interventions were equally effective in reducing pain, improving isometric strength of quadriceps, and improving functional status of patients with knee OA.

Keywords: Disability; dynamic resistance training; isometric exercises; knee osteoarthritis.

INTRODUCTION

Osteoarthritis (OA) is common, progressive health problem among adults. It is the most prevalent disease in our society, with a world wide distribution and is the second most common cause of disability among older adults [1]. It is estimated that 80% of all adults at or over age 65 years exhibit radiographic evidence of OA [2].

When symptoms of the disease affect the knee, as in 10% of all adults, it results in a limited ability to complete activities of daily living (ADLs) [3]. Many studies have indicated that the primary lesion of OA is in the articular cartilage [4]. Quadriceps strength, knee pain, and age are more important determinants of functional impairment in elderly subjects than the severity of knee osteoarthritis as assessed radiographically [5]. Among these, quadriceps weakness may be the most amenable to treatment for the prevention of knee OA.

Treatment options in OA knee may be classified as nonpharmacologic, pharmacologic, or surgical. Given their relatively low toxicity and cost, nonpharmacological strategies (such as physical therapy, including exercise) are recommended as the first-line treatment for the knee OA [6]. Long term medical management with pain relieving drugs is often hazardous. The primary goals of physical therapy are to reduce pain and decrease disability [7].

Physical therapy encompasses a variety of treatment modalities for knee OA, including manual joint mobilization, exercise prescriptions, hydrotherapy, massage, knee tapping, knee braces, and shoe insole. Although such treatments may be applied in isolation, clinical practice generally utilizes multiple treatment strategies concurrently. Numerous studies have documented the symptomatic benefits of isometric exercise for individuals with knee OA [6, 8,9 ,10].

Functional ability requires movement of the joint over a functional range. Isometric resistance training improves muscle strength only at joint angle at which the training takes place, this specificity of training principle may limit how much isometric training can affect performance of functional task that requires joint movement beyond the joint angle prescribed in the isometric training. A possible advantage of isometric training may be that it does not stress the joint over a functional range of motion. Reduced joint movement may result in less pain during and after the resistance training.

Isometric training has been shown to result in strength increases that are joint angle specific. That is, strength increases are limited to angles at or near the training joint angle [11, 12].

In contrast, dynamic resistance training in non-OA subjects improves the strength of the trained muscle over the entire range of motion (ROM). It has been reported that dynamic resistance training correlates with improve knee strength, increased neuromuscular performance on selected functional tasks. Although, dynamic resistance training improves strengths and functioning over the training ROM, the joint is being loaded while it is moved, which may result in pain in OA patients.

Since strength training affects the outcome of OA knee, thus this study aims to compare the effect of short term multiple angle isometric resistance training and dynamic resistance training on pain and function among adults with OA knee.

MATERIALS AND METHODS

The study was conducted using pretest post test experimental design at Ortho & Physiotherapy OPD, Rohilkhand Medical College, Bareilly on 60 subjects who were randomly divided into two equal groups. A total of sixty, both male (n=33) and female (n=27) patients were included in the study. The criteria for inclusion were: pain in and around knee; radiological evidence of primary osteoarthritis with grade II, III on Kellgrane-Larance scale [13]; age between 50 -75 years; unilateral or bilateral involvement, in case of bilateral more symptomatic knee was included. Subjects were excluded if they had any deformity of knee, hip, or back, limitation in knee range of motion, history of bony or soft tissue injury to knee joint, backache with radiating pain to leg, any central or peripheral nervous system involvement, received steroid or intra articular injection within previous six months, systemic inflammatory disease e. g. gout, rheumatoid arthritis, ankylosing spondylitis, had metallic implant, uncooperative patients or mentally unstable. Patient taking non-steroidal anti-inflammatory drugs had been on stable dose over the last two weeks.

Procedure

After screening for inclusion and exclusion criteria the subjects were randomly assigned into two groups with 30 subjects in each group and informed consent was obtained from the subjects. Randomization was done by permuted block randomization.

Intervention

All the subjects received hot pack at the affected knee joint and resistance training exercises according to their respective groups. The intervention was given for six weeks (6 days/week). Hot packs were given after the exercise session with patient in supine lying.

Group A: hot packs with multiple angle isometric resistance training at 30, 60 and 90 degree of knee flexion.

Group B: hot packs with dynamic resistance training.
The outcome measurements in this study were isometric knee extensor strength at 30, 60 and 90 degree of flexion, reduced WOMAC [14] score and VAS [15] score.

Measurement of isometric strength

The isometric strength of quadriceps femoris was measured by using a strain gauge at baseline (before intervention) and recorded as ISO01, ISO02, ISO03 and at the end of intervention recorded as ISO61, ISO62, ISO63 for isometric strength at 30 ,60, 90 degree of knee flexion respectively. During the testing subjects were made to sit on quadriceps table with knee joint at 30 , 60 and 90 degree of flexion .thigh was stabilized with belts; the shin pad was adjusted at 5.1 cms (2 inches) superior to the medial malleolus. The fulcrum of the lever arm was aligned with the most distal part of lateral epicondyles of the femur. The strain gauge was attached to the distal end of the quadriceps table arm.

Subjects were given verbal encouragement in order to motivate to attain maximum effort during the 5 seconds contraction. Each test included 3 consecutive trials with 30 seconds rest in between the trials. The mean of 3 readings was used for the purpose of analysis.

Measurement of functional score

The functional score was assessed by using reduced WOMAC scale. The reading were taken at baseline (before intervention) and after the end of six weeks and marked as WOMAC0 and WOMAC6 respectively.

Measurement of pain intensity

Pain was assessed using a horizontal analog scale. The reading were taken at the baseline and at the end of intervention and marked as VAS0 and VAS6 respectively.

DATA ANALYSIS

A pre-post experimental (parallel group) study was used for the study. The values collected were that fit the dependent and independent variables – isometric strength at 30, 60, 90 degree of knee flexion, functional index using reduced WOMAC score, pain intensity using VAS.

The baseline value for the isometric strength , functional index, and pain intensity were taken on day one designated as ISO01, ISO02, ISO03, WOMAC0 AND, VAS0) and final reading was taken at the end of 6 weeks i.e. on the end of intervention(designated as ISO61, ISO62, ISO63, WOMAC6 and VAS6 respectively) the data was analyzed using the SPSS 15 software.

Paired t-test was used for comparison of strength with the groups. Independent t-test was used to compare the strength between the groups, the values of both of the two groups i.e. group A and Group B were compared at baseline and post intervention. The test was applied at 95% confidence interval and p value set at 0.05. The results were taken to be significant if $p<0.05$.

RESULTS

Within group analysis in Group A revealed that there was a statistically significant difference ($p<0.05$) in isometric strength of quadriceps at 30, 60, and 90 degrees of knee flexion after 6 weeks of training, when compared to the baseline values. The mean improvements in isometric strength at 30^{o} were

3.34±1.06; at 60^o was 4.12±1.52 and at 90^o was 3.55±1.06. Within group analysis in Group B revealed that there was a statistically significant difference ($p<0.05$) in isometric strength of quadriceps at 30, 60, and 90 degrees of knee flexion after 6 weeks of training, when compared to the baseline values. The mean improvements in isometric strength at 30^o were 3.75±1.47; at 60^o was 4.51±1.32 and at 90^o was 3.71±1.29. (Table. 1)

Table. 1: Isometric strength of quadriceps at 30, 60, and 90 degrees of knee flexion after 3 weeks of training.

	Knee Flexion	Pre Test Mean±SD (in Newton)	Post Test Mean±SD (in Newton)	t value	p value
Group A	At 30^0	5.01±1.71	8.34±2.31	-12.19	<.05
	At 60^0	6.25±2.07	10.37±2.89	-10.45	<.05
	At 90^0	5.66±1.98	9.21±2.39	-12.93	<.05
Group B	At 30^0	4.70±1.26	8.46±1.53	-9.87	<.05
	At 60^0	6.12±1.47	10.63±1.76	-10.12	<.05
	At 90^0	5.50±1.44	9.22±1.59	-11.07	<.05

Table 2: Within group analysis of VAS Scores

	Pre Test Mean±SD	Post Test Mean±SD	t	p
Group A	6.84±1.17	2.57±1.11	10.32	<.05
Group B	6.83±1.38	2.47±1.39	10.89	<.05

Table3: Within group analysis of WOMAC

	Pre Test Mean±SD	Post Test Mean±SD	T	p
Group A	20.73±3.75	9.33±2.76	10.68	<.05
Group B	22.67±3.79	10.33±3.73	11.7	<.05

Within group analysis in Group A revealed that there was a statistically significant difference ($p<0.05$) in VAS Score after 6 weeks of training when compared with baseline values. The mean improvements in VAS Score were 4.3±1.6. Within group analysis in Group B revealed that there was a statistically significant difference ($p<0.05$) in VAS Score after 6 weeks of training when compared with baseline values. The mean improvements in VAS Score were 4.36±1.56. (Table. 2)

Reduced WOMAC Index Score

Within group analysis in Group A revealed that there was a statistically significant difference ($p<0.05$) in WOMAC Score after 6 weeks of training when compared with baseline values. The mean improvement in WOMAC Score was 11.4±4.15.

Within group analysis in Group B revealed that there was a statistically significant difference ($p<0.05$) in WOMAC Score after 6 weeks of training when compared with baseline values. The mean improvements in WOMAC Score were 12.33±4.08. (Table. 3)

DISCUSSION

This study provides important information about the efficacy of Dynamic resistance training and multiple angle isometric resistance training on quadriceps strengthening in OA patients. Both the two groups showed a significant reduction in pain, improvement in isometric strength of quadriceps, and improvement in functional index scale from their base line values. But when compared between the groups, there was no significant difference observed. Thus suggesting that both the interventions were equally effective in reducing pain, improving isometric strength of quadriceps, and improving functional status of OA patients. The old idea that isometric exercise is the only correct exercise for people with arthritis is challenged by this study.

The results of the resistance training tested in the current study appear to have a greater percentage impact on improving actual functional measures and reducing pain than previous exercise interventions. The Fitness Arthritis and Seniors Trial [16] reported a modest 8%to 10% improvement in pain and functioning scores as a result of 18 months of aerobic or resistance exercise among their sample of knee OA patients. This modest, although significant, effect of a long-term exercise program, which included resistance training, was also reported by Rogind et al [17]. Even the previously cited reviews [10, 18] of the literature indicated that exercise seems to have a small to moderate effect on joint pain and functional outcome measures with a more moderate effect on self-perceived measures of functioning. Our finding suggests that resistance training interventions reduced pain and increased functional ability similarly or to a greater extent than the previously studied interventions and that too in a lesser duration. This may be possibly due to the fact that, the present interventions were primarily resistance training and may have required a

higher intensity of training than the previous studies. The results of this study support the efficacy of resistance training program in management of OA patients, as both the intervention protocols were resistance training methods. This is in agreement with various other studies which support that activities involving strengthening of quadriceps are helpful in the management of OA knee patients [19].

Several investigators [20, 21] have reported declines in the sensorimotor function of the quadriceps (proprioception) among knee OA patients. This decline may be a primary factor contributing to the development and progression of knee OA [22]. If proprioception is impaired, the timing of the eccentric contraction of the quadriceps during weight-bearing activities will be clumsy, thus resulting in higher impact and impulsive loads being transmitted through the joint [23]. These higher loads being transmitted through the knee joint will lead to micro trauma to the articular cartilage and/or the subchondral bone, which are characteristics of knee OA [24]. A hypothesized outcome of resistance training of the leg is an increased sensitivity in the sensorimotor structures of the quadriceps including the muscle spindles and Golgi tendons [25]. Resistance training has been shown to increase the alpha motor discharge or tone of the muscles trained. This alpha motor neuron activity is reciprocally influenced by muscle spindles and Golgi complex within the muscles. Thus, regular resistance training may lower the impact and impulsive loads through the knee joint not by only increasing the strength of the muscle surrounding the knee joint but also by increasing sensitivity and coordination of the proprioceptors within the quadriceps muscle [26].

The reduced WOMAC score showed improvement in both of the two groups from baseline. But when compared between groups the results were found to be statistically insignificant. Thereby suggesting both the two types of resistance training is equally effective in improving the functional status of the patients. Pain is a major factor to the disability in the patients with osteoarthritis knee. Hence, reduction in pain can explain a concomitant improvement in the functional status of the patients. Disability in OA is due not only to the arthritis but also to the inactivity associated with the disease and with aging. It has been postulated that resistance training increases the hyaluron levels in the OA knee patients. With repeated muscle contraction there occurs a synovial cell stimulation which is responsible for activating hyaluron synthesis. This viscous hyaluron is much suited to joint lubrication and thus help in alleviating pain. Thus it can be the factor that could have lead to a reduction in pain after resistance training.

CONCLUSION

The dependent variables of interest which were strength, pain intensity and reduced WOMAC score found to improve from the baseline value in both of the two groups. The study therefore proves that both the interventions are equally effective for improvement of knee pain and functional ability in the patients of osteoarthritis of knee.

LIMITATIONS

- Small duration of intervention
- Lack of follow up
- Limited age group

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